Claims

What is claimed is:

1. An apparatus for making a crystal pre-melt, comprising:

a hermetically-sealable muffle furnace made of a non-porous refractory material;

at least one port for entry and exit of gaseous substance within the muffle furnace;

a temperature-controlled zone defined inside the muffle furnace; and

a crucible for holding crystal raw material in solid or molten form inside the muffle furnace.

2. The apparatus of claim **1**, wherein the temperature-controlled zone is defined by at least one heater disposed external to the muffle furnace.

3. The apparatus of claim **2**, wherein the heater is movable relative to the muffle furnace so as to allow heat to be uniformly distributed to the temperature-controlled zone.

4. The apparatus of claim **1**, wherein the temperature-controlled zone is defined by a conductive portion of the muffle furnace.

5. The apparatus of claim **1**, wherein the non-porous refractory material is selected from the group consisting of quartz, alumina, silicon carbide, vitreous graphite, vitreous carbon, glassy carbon-coated graphite, and combinations thereof.

6. The apparatus of claim **1**, wherein the crucible is made of a non-porous refractory material selected from the group consisting of quartz, alumina, silicon carbide, vitreous graphite, vitreous carbon, glassy carbon-coated graphite, and combinations thereof.

7. The apparatus of claim **1**, wherein the at least one port is provided in an end cap fitted in sealed contact at an end of the muffle furnace, and wherein the end cap is made of a non-porous refractory material selected from the group consisting of quartz, alumina, silicon carbide, vitreous graphite, vitreous carbon, glassy carbon-coated graphite, and combinations thereof.

8. The apparatus of claim **1**, wherein the crucible is movably supported inside the muffle furnace.

9. The apparatus of claim **1**, further comprising means for suspending a porous preform made of crystal raw material in the temperature-controlled zone.

10. A method of making a crystal pre-melt, comprising:

disposing crystal raw material in loose powder, pressed powder, granular, or densified form in a temperature-controlled zone defined in a muffle furnace made of a non-porous refractory material and hermetically sealing the muffle furnace;

heating the temperature-controlled zone to a treatment temperature that enables reaction between a fluorinating agent and oxides in the crystal raw material;

reacting the fluorinating agent with the crystal raw material to produce volatile gases and removing the volatile gases from the muffle furnace;

heating the crystal raw material to form a melt; and

solidifying the melt to form the crystal pre-melt.

11. The method of claim **10**, wherein solidifying the melt comprises forming droplets from the melt and solidifying the droplets to form the crystal pre-melt.

12. The method of claim **10**, wherein the fluorinating agent is a gas selected from the group consisting of CF_4, NF_3, SF_6, BF_3, C_2F_4, HF, F_2, and mixtures thereof, and similar fluorinating gases known in the art.

13. The method of claim **12**, wherein the fluorinating agent is supplied into the muffle furnace in a stream of inert gas.

14. The method of claim **10**, wherein the fluorinating agent is a solid mixed with the crystal raw material prior to disposing the crystal raw material in the temperature-controlled zone.

15. The method of claim **10**, wherein the non-porous refractory material is selected from the group consisting of quartz, alumina, silicon carbide, vitreous graphite, vitreous carbon, glassy carbon-coated graphite, and combinations thereof.

16. The method of claim **10**, wherein heating the crystal raw material to the treatment temperature occurs in multiple steps.

17. The method of claim **10**, wherein heating the crystal raw material to the treatment temperature and heating the crystal raw material to form the melt occur in an inert atmosphere.

18. The method of claim **10**, wherein disposing the crystal raw material in the temperature-controlled zone comprises loading the crystal raw material into a crucible and disposing the crucible in the temperature-controlled zone.

19. The method of claim **10**, wherein disposing the crystal raw material in the temperature-controlled zone comprises suspending the crystal raw material in pressed powder form in the temperature-controlled zone without use of a crucible.

20. The method of claim **10**, wherein the crystal material is a metal fluoride selected from the group consisting of CaF_2, BaF_2, MgF_2, SrF_2, LiF, NaF, $(M_1)_x(M_2)_{1-x}F_2$, and M_3AlF_6, and mixtures thereof; and where M_1 is selected from the group consisting of Li, K, and lanthanide series metal fluorides; M_2 is selected from the group consisting of Ca, Ba, Mg, Sr, and lanthanide series metal fluorides; M_3 is selected from the group consisting of Li, Na, K, Rb, and Cs; and x is in a range from 0 to 1.